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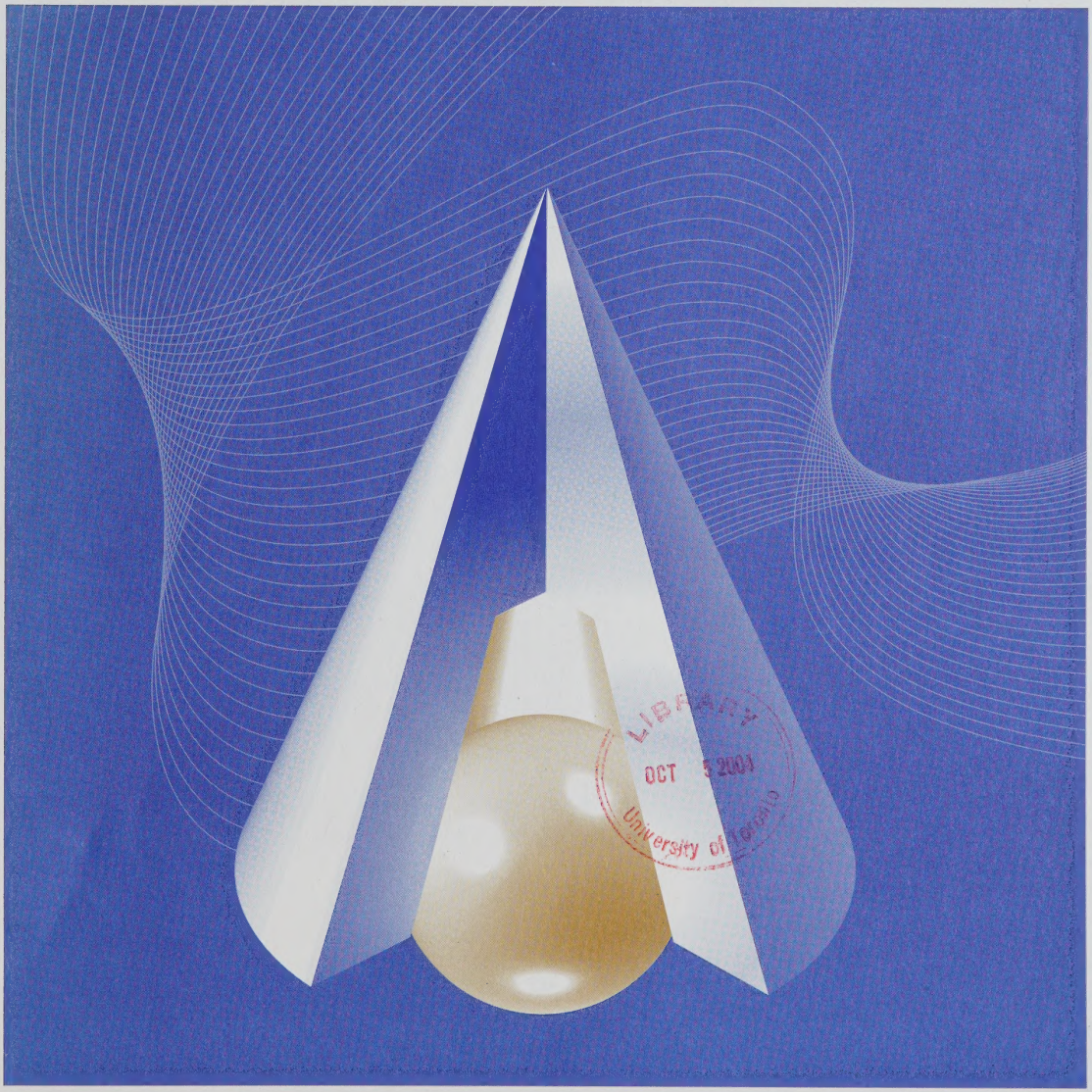

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Analytical Studies, Statistics Canada
24th Floor, R.H. Coats Building
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(613) 951-1804

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Business and Labour Market Analysis Division
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ABSTRACT

The present study extends previous work on the evolution of the education premium and investigates the existence of diverging university/high school earnings ratio trends across industries in the knowledge-based economy. The study also provides additional information about the changing demand for high-skilled workers by comparing relative wages of university graduates holding degrees in "applied" fields to those of other university graduates ("field" premium). The main finding of this paper is that even though employment grew much faster in high-knowledge industries than in other sectors during the last two decades, trends in relative wages and real wages of university and high school graduates have displayed remarkably similar patterns across industries.

Keywords: Returns to education, knowledge-based economy, earnings.

JEL: I21, J31.

1. Introduction

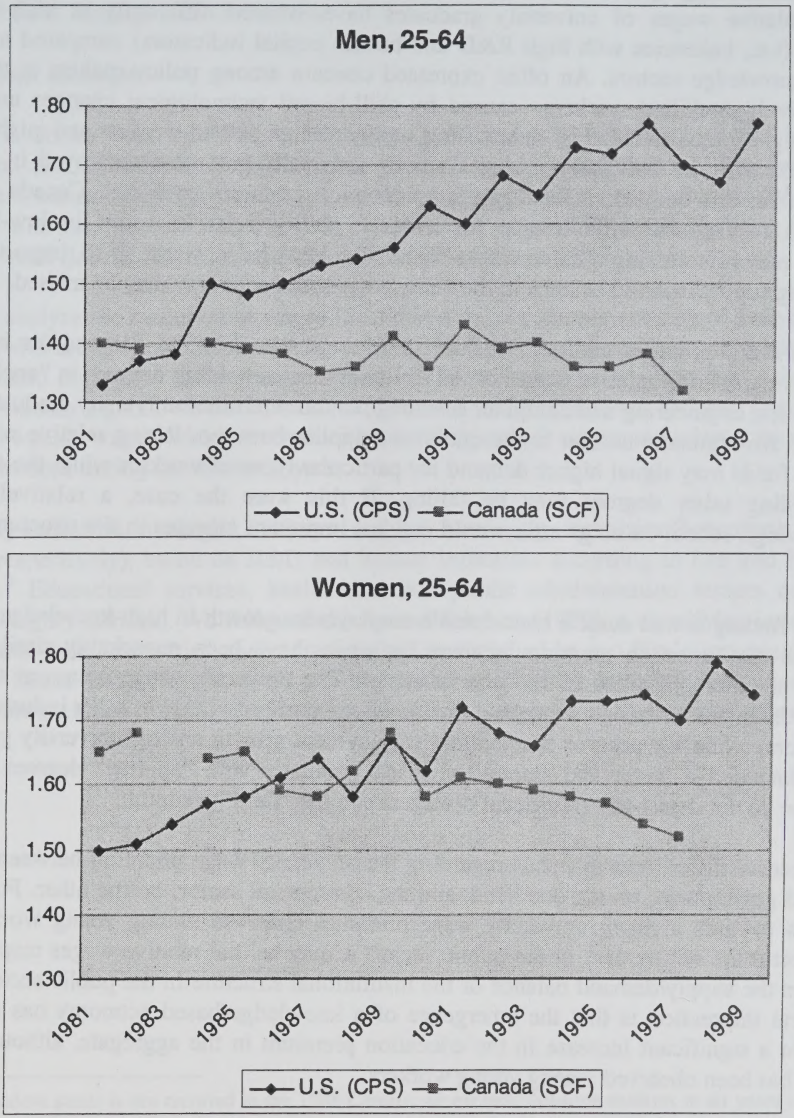
One of the debates in the economic literature concerns the interpretation of the changes in the relative wages of university and high school graduates (i.e., the "university premium" or "education premium"). Does the rising education premium signal changes in the supply and demand balance between university and high school graduates (as most studies argue), or does it pertain to changes in institutional factors (unionization level, public sector policies, etc.), trade balance and other factors? Although all these factors may contribute to the changes in relative wages of university graduates, researchers attempt to pinpoint leading determinants of the education premium. Understanding this mechanism is important by itself and may provide further insights into the role of human capital in economic growth, the problem of income inequality and other economic issues. Furthermore, policy makers may adopt different strategy towards educational subsidies if such subsidies lower relative wages by facilitating shifts in the education attainment of the work force (Murphy et al., 1998).

Several studies have observed that despite many similarities between the American and Canadian economies, the relative wage trends in the U.S. and Canada in the past 20-25 years have been quite different. Figure 1, taken from Burbidge et al., (2002) shows how median weekly earnings of male and female university graduates, aged 25-64 and employed full-time, have evolved relative to their counterparts with no university degree. In the United States, the university/non-university weekly earnings ratio has increased from 1.3 in 1981 to almost 1.8 in 1999 for men. During the 1981-2000 period, the corresponding ratio has remained almost unchanged around 1.4 in Canada. Relative weekly earnings of female university graduates have also increased in the United States (from 1.5 in 1981 to 1.74 in 1999) but they have fallen in Canada (from 1.65 to 1.5).

The U.S.–Canada differences have been exploited with different conclusions (Freeman and Needels, 1993; Card and Lemieux, 2001; Burbidge et al., 2002). As Burbidge et al., (2002) remark, "authors have located themselves on a spectrum running from demand-and-supply-explains-everything to institutional-differences-explain-everything" (p.210). Most studies relate the U.S.-Canada differences in education premium to differences in the relative supply of university graduates (Freeman and Needels, 1993; Murphy et al., 1998). Burbidge et al., (2002) on the other hand, argue that the relationship between the supply of university graduates and wage premium is far from being clear-cut. They observe that while the U.S.–Canada differences in skill premium can be explained by differences in the relative supply of young university graduates for the period 1988 to 1999, this relationship does not hold for the period 1981 to 1988.

Recently, more attention has been paid to disaggregating relative wage trends into gender or age specific trends. For instance, younger and older workers may not be perfect substitutes and if so, different relative wage patterns can emerge. Card and Lemieux (2001) show that most of the growth in relative wages of university graduates in the U.S. can be attributed to younger workers. They conclude that the rising premium to higher education among the younger but not older workers is related to: 1) steadily increasing relative demand for more highly educated workers, and, 2) changes in cohort-specific supply of highly educated workers. Notably, growth in the educational attainment of the young stopped in the 1980s and 1990s, but continued among other cohorts.

Figure 1: Weekly earnings of "full-time" workers in the U.S. and Canada



Note: Data for U.S. (CPS) – Current Population Survey, Canada (SCF) – Survey of Consumer Finances. SCF for 1983 is not available.
Source: Burbidge et al., (2002)

This study extends previous work on the evolution of the education premium in three ways. First, the study includes evidence from the most recent Canadian Census, thereby analyzing the evolution of wage differences across education levels over the 1980-2000 period.

Second, it investigates whether the constancy of the university/high school earnings ratio, observed in the aggregate, masks offsetting trends across industries. Specifically, it assesses whether relative wages of university graduates have evolved differently in high-knowledge industries (i.e., industries with high R&D and human capital indicators) compared to medium- and low-knowledge sectors. An often expressed concern among policy makers is that greater demand for high-skilled workers—caused by skill-biased technological changes and/or other forces—might not be satisfied by the existing supply of high-skilled workers and might result, *at least temporarily*, in fast-growing wages among university graduates employed in expanding industries.[1] In this context, a flat aggregate education premium profile in Canada may mask differences in sector-specific trends; for instance, falling relative wages in low-knowledge industries may offset rising relative wages in the high-knowledge sector. If so, important signals of changing supply/demand balance in the knowledge-based economy may be missed.

Third, the study provides additional information about the changing demand for high-skilled workers by comparing relative wages of university graduates holding degrees in "applied" fields (mathematics, engineering and computer sciences), to those of other university graduates ("field" premium). An argument similar to the one above applies here too. Rising relative wages in the "applied" fields may signal higher demand for particular types of workers while the demand for those holding other degrees may be falling. If this were the case, a relatively constant university/high school earnings ratio would conceal important changes in the structure of labour demand.

The main finding is that despite considerable employment growth in high-knowledge industries, changes in the education premium in these industries have been remarkably similar to those observed in other industries of the private sector. The university wage premium tends to be higher in the high-knowledge sector, but the trends are similar to those of other industrial sectors. Furthermore, while we observe accelerating employment growth among university graduates in the high-knowledge sector and among university graduates with "applied" degrees in the late 1990's, we do not detect any significant divergence in the "field" premium.

We do observe differences in trends regarding the university wage premium between the public sector and government, on the one hand, and the commercial sector, on the other. For example, the trends towards a rising university wage premium observed among young workers in the private sector are not evident in the public sector. It may be that relative wages respond less to changes in the supply/demand balance or the institutional structure in the public sector. Overall, our general impression is that the emergence of a knowledge-based economy has not, so far, resulted in a significant increase in the education premium in the aggregate, although a rising premium has been observed among young workers.

We proceed as follows. In Section 2, we discuss our data sample and define our industry classification. Section 3 documents employment trends by industry and field of study over the last two decades. Section 4 compares the evolution of the education premium for workers of

1. Efficiency wage models (e.g., Salop, 1979, Shapiro and Stiglitz, 1984) explain why firms pay observationally equivalent workers different wages, even in the presence of labour mobility. They could also explain why observationally equivalent workers enjoy, over a given period, faster earnings growth than those in other industries. For instance, if the costs of training high-skilled workers rose faster in some industries than in others, firms in the former set of industries may find it profitable to raise wages of these workers in order to reduce labour turnover and restrict the growth of training costs.

different age groups. Section 5 explores the differences in education premium profiles by industry. Section 6 investigates the issue of a "field" premium. Finally, Section 7 offers a summary of our findings and conclusions.

2. Data and concepts

The data is drawn from the 1981, 1986, 1991, 1996 and 2001 Census files and is based on information for approximately five percent of the Canadian population. When we examine employment trends (Section 3) or labour supply trends, our sample consists of individuals aged 25 to 55, who are not full-time students, and who are employed or active during the Census reference week (i.e., in May/June of 1981, 1986, 1991, 1996 and 2001).[2]

When we analyze the evolution of wages (Sections 4-6), our sample consists of individuals aged 25 to 55, who are not full-time students, and who had positive wages and salaries and positive weeks worked during the reference year (e.g., 1980 for Census 1981). In order to focus on the returns to human capital, we exclude individuals with self-employment income. Our dependent variable is weekly wages, which is obtained by dividing annual wages and salaries by the number of weeks worked during the reference year.

We classify industries into high-, medium-, and low-knowledge industries (henceforth HKI, MKI and LKI respectively), based on R&D and human indicators according to Lee and Has (1996) (Table 1).[3] Educational services, health care and public administration sectors constitute a separate category (EHPA). We follow Baldwin and Johnson (1999) in classifying industries into HKI (science-based industries, their terminology) but retain Lee and Has's grouping into MKI and LKI. Some industries have mixed high- and medium-knowledge components. These industries are included in HKI when the high-knowledge components appear to dominate.

2. Since student status is not reported in the 1986 Census, we exclude full-time students in all years except 1985. Freeman and Needels (1993) find that the inclusion of full-time students in 1985 does not substantially affect conclusions regarding the evolution of the education premium.

3. Lee and Has (1996) divide industries on the basis of three R&D measures: the R&D-to-sales ratios, the proportion of R&D personnel to total employment, and the proportion of professional R&D personnel to total employment; and three measures of human capital: the ratio of workers with postsecondary education to total employment, the ratio of knowledge workers (occupations in the natural sciences, engineering and mathematics, education, management and administration, social sciences, law and jurisprudence, medicine and health, and writing) to total employment, and the ratio of the number of employed scientists and engineers to total employment (Baldwin and Johnson (1999): 21). High-knowledge industries are those that fall in the top third on the basis of two of the R&D measures *and* two of the human capital indices.

Table 1: Knowledge intensity classification

High-knowledge	Medium-knowledge	Low-knowledge
Scientific and professional equipment	Other manufacturing products	Fishing and trapping
Communication and other electronic equipment	*Management consulting services*	Other electrical products
Aircraft and parts	*Other business services*	Wood
Office, store and business machines	Other transportation equipment	Furniture and fixture
Architecture, engineering, scientific and related services	Primary metals, ferrous and non-ferrous	Logging and forestry
Pharmaceutical and medicine products	Textiles	*Transportation*
Electric power systems	Paper and allied industries	*Storage and warehouse*
Other chemical products industries	Mining (includes quarries in 2001)	Agriculture
Machinery	Rubber	*Retail trade*
Refined petroleum and coal products	Plastics	*Personal services*
Pipeline transportation	Non-metal mineral products	Quarries and sand pits
Other telecom industries	*Wholesale trade*	*Accommodation, food and beverage services*
Services incidental to agriculture	Crude petrol and gas	Clothing
Industrial chemical industries	Fabricated metal products	Leather
Record player, radio and TV receiver industries	Motor vehicles and parts	
Plastic and synthetic resin industries	Food	
Electrical industrial equipment industries	Beverages	
Agricultural chemical industries	Tobacco	
Communication and energy wire and cable industries	*Finance insurance and real estate*	
*Computer and related services**	*Other utilities (excl. electrical power)*	
Telecommunication broadcasting industries*	*Services incidental to mining*	
Motion picture, audio and video production and distribution*	*Other services*	
	Printing and publishing	
	Construction	
	Amusement and recreational services (except motion picture production and distribution)	
	Postal and courier service	
	Membership organizations	
	Accounting and bookkeeping services	
	Advertising services	
	Offices of lawyers and notaries	
	Employment agencies	
	Railroad rolling stock industry	
	Boatbuilding and repair industry	
	Jewellery, sporting goods & toys, sign & display industry	
	Household appliance manufacturing	
	Paint & varnish, soap & cleaning compounds, and toilet preparations industries	

Note: * indicates industries with mixed components; *italics* indicate commercial services
Source: Baldwin (1999) and Lee and Has (1996).

The categories in italics in Table 1 show which service-producing industries are included in HKI, MKI and LKI. These industries are explicitly identified as services in an industry classification (for instance, *Engineering and Scientific Services* or *Services Incidental to Mining*) as well as industries that, in our judgement, do not involve production (*Transportation, Storage and Warehousing*, etc.). We identify 24 service industries in all three sectors.

The industry classifications available in Census data vary over time. Most of the census files used in the study provide the SIC80 industry classification.[4] However, the 1981 Census provides only the SIC70 classification, while the 2001 Census provides only the NAICS97 classification. While the differences between SIC70 and SIC80 can often be easily reconciled, the differences between NAICS97 and SIC80 are more problematic. The 2001 census data files provide only four-digit NAICS97 codes and some of our matching decisions have required judgement calls. Although more detailed codes would further improve matching, we believe that, for the most parts, we are able to match NAICS97 and SIC80 fairly closely based on the full description of each industry code.

We group educational attainment into four categories: less than high school, high school (but no post-secondary education), some post-secondary education and a completed university degree (Bachelor or higher). Contrary to studies combining data from the Survey of Consumer Finances, the Survey of Labour and Income Dynamics and the Labour Force Survey (e.g., Burbidge et al., 2002), our measure of educational attainment is fully consistent over time since the educational categories used in various Censuses have remained constant throughout the period.[5]

We also consider two age groups as labour market conditions for younger workers (aged 25-35) likely differ from those faced by older workers (aged 36-55). Those in the early stages of their professional careers are less likely to have access to internal labour markets and their wages and employment status are likely to be more sensitive to changes in demand. This is also consistent with previous studies which document different education premium profiles for different age groups in Canada.

The information on total years of schooling that would allow us to determine individual experience is only available for 1985, 1990 and 1995. We construct a "potential experience" variable to proxy actual experience. We define "potential experience" as 'age' minus "potential years of schooling" minus 6 (the usual age of entering primary school), where "potential years of schooling" are calculated as conditional means of total years of schooling for each level of education in 1985-1995 (i.e., years for which variable "total years of schooling" is available).

4. Both Baldwin and Johnson (1999) and Lee and Has (1996) base their classification on SIC80.

5. In contrast, studies combining the aforementioned surveys rely on the Labour Force Survey education question, whose wording changed in 1989. Because of these changes in the LFS education question, Burbidge et al., (2002) are constrained to compare the earnings of university graduates to those of *all other* workers, which constitutes a fairly wide category whose educational attainment can rise over time. Our use of comparable educational categories allow us to compare earnings of university graduates to those of high school graduates, two categories which are conceptually well defined.

3. Employment trends: 1981-2001

Between 1981 and 2001, total employment rose 49% in Canada (Table 2). Employment growth was spread unequally as employment in high-knowledge industries rose a solid 84%, much more than the rates observed in medium- and low-knowledge industries (52% and 32%, respectively). Half of the employment growth of the high-knowledge sector took place during the second half of the 1990s. Employment in this sector rose much faster among service-producing firms than among their goods-producing counterparts. In fact, employment in the former group almost tripled while it rose only 33% among the latter group. As a result, service-producing firms ended up accounting for about one half of all jobs in high-knowledge industries in 2001, a much larger proportion than observed in 1981 (33%). The faster employment growth observed in service-producing firms occurred also in low- and medium-knowledge industries, although at a more moderate pace. By 2001, high-knowledge industries accounted for roughly 10% of total employment, compared to 8% in 1981.

Table 2: Shares of employment (%) and employment growth by knowledge-based sectors

	Shares of employment					*Employment growth (1981=1)*			
	1981	**1986**	**1991**	**1996**	**2001**	**1986**	**1991**	**1996**	**2001**
Low-knowledge	28.8	29.0	28.0	27.3	25.5	1.15	1.27	1.31	1.32
services	72.2	73.8	77.2	78.4	76.8	1.17	1.35	1.43	1.40
goods						1.08	1.04	1.02	1.11
Medium-knowledge	38.8	37.5	37.2	38.5	39.7	1.10	1.25	1.38	1.52
services	46.2	50.7	53.8	58.1	58.8	1.21	1.45	1.73	1.94
goods						1.00	1.08	1.07	1.17
High-knowledge	7.9	7.8	8.0	8.2	9.8	1.12	1.32	1.43	1.84
services	33.4	34.7	41.7	43.8	52.0	1.17	1.65	1.88	2.87
goods						1.10	1.16	1.21	1.33
Education, Health and PA	24.6	25.8	26.8	26.1	25.0	1.19	1.42	1.48	1.51
Total						1.14	1.30	1.39	1.49
services*	54.8	58.0	61.3	64.0	64.0	1.19	1.41	1.59	1.73
goods*						1.04	1.08	1.08	1.18

Note: * excluding 'Education, Health and PA'
Source: Data from the 1981, 1986, 1991, 1996 and 2001 Census files.

Between 1981 and 1996, employment of university graduates grew at a remarkably similar pace in HKI, MKI and LKI. However, the number of jobs held by university graduates rose drastically in HKI between 1996 and 2001. As a result, employment of university graduates in HKI registered an increase of 245% (3.45-1) between 1981 and 2001, a much faster increase than those observed in other industries (Table 3). Meanwhile, the number of employed high school graduates rose only 31% in high-knowledge industries, compared to 75% and 92% in medium- and low-knowledge industries, respectively. As a result, the ratio of employment of university

graduates to high school graduates grew from 1.3 to 3.4 in HKI.[6] The corresponding ratio rose only from 0.7 to 1.1 in medium-knowledge industries and from 0.3 to 0.4 in low-knowledge industries. Similar conclusions hold when we consider the ratio of employment of individuals with *at least* some post-secondary education to those with *at most* a high school diploma.

Table 3: Shares of employment (%) and employment growth by knowledge-based sectors and levels of educational attainment

	Shares of employment					*Employment growth (1981=1)*			
	1981	**1986**	**1991**	**1996**	**2001**	**1986**	**1991**	**1996**	**2001**
Low knowledge									
University	4.3	5.3	6.0	7.7	8.8	1.41	1.78	2.38	2.71
Some post-secondary	33.3	35.9	39.0	42.9	44.1	1.24	1.48	1.70	1.75
High school	13.6	15.0	18.9	19.4	19.8	1.26	1.76	1.88	1.92
Less than high school	48.9	43.8	36.1	29.9	27.4	1.03	0.93	0.80	0.74
Medium knowledge									
University	9.9	11.8	13.7	16.3	17.8	1.32	1.74	2.30	2.78
Some post-secondary	40.1	42.1	44.1	46.7	47.8	1.15	1.37	1.59	1.81
High school	14.0	14.7	17.2	16.8	16.1	1.15	1.54	1.66	1.75
Less than high school	36.2	31.5	25.0	20.4	18.4	0.96	0.86	0.78	0.77
High knowledge									
University	17.9	21.0	24.3	29.0	33.6	1.32	1.79	2.33	3.45
Some post-secondary	46.9	48.0	49.7	49.6	49.2	1.15	1.40	1.52	1.93
High school	13.9	13.3	13.6	11.8	9.9	1.07	1.29	1.22	1.31
Less than high school	21.3	17.7	12.4	9.6	7.4	0.93	0.77	0.64	0.64
Education, Health and PA									
University	30.1	32.7	32.5	35.7	37.5	1.30	1.54	1.75	1.89
Some post-secondary	42.7	43.8	45.1	45.4	46.2	1.22	1.50	1.57	1.64
High school	9.5	9.3	10.9	10.3	9.3	1.17	1.64	1.60	1.49
Less than high school	17.7	14.2	11.4	8.7	7.0	0.93	0.92	0.72	0.60
Total									
University	13.8	16.0	17.4	20.1	22.0	1.32	1.64	2.01	2.36
Some post-secondary	39.3	41.2	43.4	45.5	46.6	1.19	1.44	1.60	1.76
High school	12.8	13.3	15.7	15.4	14.7	1.18	1.60	1.68	1.72
Less than high school	34.1	29.6	23.4	19.0	16.8	0.99	0.89	0.77	0.73

Source: Data from the 1981, 1986, 1991, 1996 and 2001 Census files.

Hence, high-knowledge industries both increased their employment levels and the average education level of their workforce much more rapidly than medium- and low-knowledge industries during the 1981-2001 period. This suggests that the demand for high-skilled workers rose faster in HKI than in MKI and LKI.

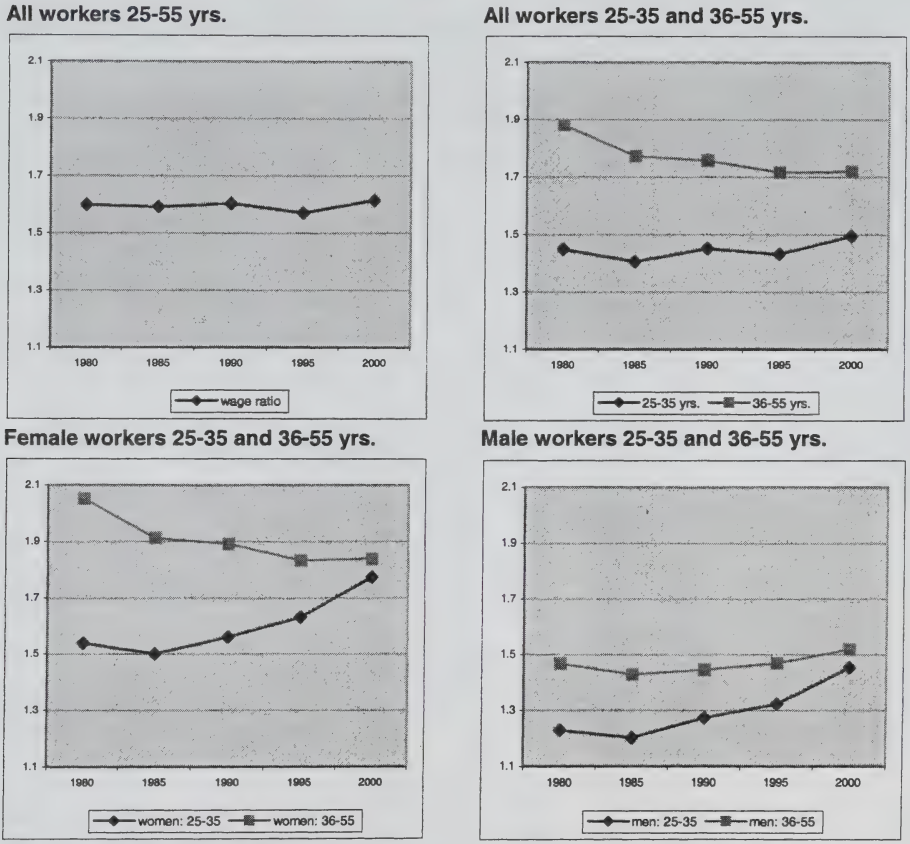
4. Exploring gender and age differences

We begin by demonstrating the importance of disintegrating relative weekly wages profiles of university graduates in Canada by looking at the differences in age and gender wage profiles. Figure 2 shows the ratio of median weekly earnings of university graduates to those of high school graduates over the 1980-2000 period. The ratio is presented for all workers aged 25 to 55

6. Between 1980 and 1995, it rose from 1.3 to 2.5. It then increased further to 3.4 between 1995 and 2000.

(top left panel), workers aged 25-35 and those aged 36-55 (top right panel), women from both age groups (bottom left panel) and finally, men from both age groups (bottom right panel).

Figure 2: University/high school wage ratio



Source: Census data 1980-2000.

In the aggregate, the university premium displays no trend; relative median weekly wages of university graduates (compared to high school graduates) have been holding steady at about 1.6 since 1980. The picture is quite different if we look separately at younger (age 25-35) and older (36-55) workers. While relative median weekly wages for older workers are higher, they have fallen from about 1.9 in 1980 to slightly above 1.7 in 2000. During the same period, relative median weekly wages for younger workers have slightly increased from about 1.45 to 1.50.

Further decomposition by sex shows a particularly large decline in the relative median weekly wages of prime-aged women (from over 2.0 in 1980 to slightly over 1.8 in 2000) and growth in the relative median weekly wages of younger women (from under 1.6 in 1980 to about 1.8 in 2000). Relative median weekly wages of men rose in both age groups. However, the growth was larger for younger men.

Table 4: Shares of labour force (%) and employment growth by sex, age group and levels of educational attainment

	Shares of labour force					*Labour force participation growth (1981=1)*			
	1981	1986	1991	1996	2001	1986	1991	1996	2001
Women (25-35)									
University	15.4	16.3	17.1	22.7	28.1	1.30	1.52	1.85	2.11
Some post-secondary	41.9	44.4	47.5	50.1	50.3	1.30	1.55	1.49	1.38
High school	18.8	17.7	18.1	14.6	10.9	1.15	1.31	0.97	0.67
Less than high school	23.9	21.6	17.2	12.6	10.6	1.11	0.99	0.66	0.51
Women (36-55)									
University	8.0	12. 2	14.8	17.7	19.6	1.96	3.14	4.43	5.80
Some post-secondary	35.7	38.7	40.8	43.5	45.6	1.39	1.93	2.43	3.00
High school	12.9	14.0	18.4	18.7	17.9	1.39	2.40	2.89	3.26
Less than high school	43.5	35.2	25.9	20.1	16.9	1.04	1.01	0.92	0.92
Men (25-35)									
University	16.7	16.1	15.4	18.2	21.6	1.06	1.04	1.09	1.15
Some post-secondary	43.2	44.0	45.6	47.2	48.3	1.11	1.19	1.10	0.99
High school	13.4	13.3	15.1	14.8	13.5	1.08	1.26	1.12	0.89
Less than high school	26.8	26.6	24.0	19.8	16.6	1.08	1.01	0.74	0.55
Men (36-55)									
University	12.9	16.6	18. 7	19.8	20.5	1.43	1.89	2.23	2.60
Some post-secondary	35.8	38.0	40.8	43.3	44.8	1.18	1.48	1.76	2.05
High school	8.6	9.7	12.5	13.4	14.0	1.27	1.90	2.28	2.68
Less than high school	42.7	35.7	28.0	23.6	20.8	0.93	0.87	0.81	0.80
Total (25-35)									
University	16.1	16.2	16.2	20.3	24.7	1.15	1.23	1.39	1.52
Some post-secondary	42.7	44.2	46.5	48.6	49.3	1.19	1.33	1.26	1.15
High school	15.6	15.2	16.5	14.8	12.3	1.12	1.29	1.04	0.78
Less than high school	25.6	24.4	20.9	16.4	13.8	1.09	1.00	0.71	0.53
Total (36-55)									
University	11.0	14.7	17.0	18.8	20.1	1.58	2.24	2.84	3.47
Some post-secondary	35.8	38.3	40.8	43.4	45.2	1.26	1.65	2.02	2.41
High school	10.2	11.5	15.1	15.8	15.8	1.33	2.14	2.57	2.96
Less than high school	43.0	35.5	27.1	22.0	18.9	0.97	0.91	0.85	0.84

Source: Data from the 1981, 1986, 1991, 1996 and 2001 Census files.

Having observed substantial differences in the patterns for male and female university graduates from different age groups, we now examine how changes in relative wages are related to changes in the relative supply of university graduates. To do so, we show, for each gender-age group, the fraction of labour force participants with a given education level during Census reference week (Table 4).

Not surprisingly, we observe substantial increases in the relative supply of university graduates for both men and women of all ages. Changes among young women are particularly impressive. While in 1981 there were more young women with high school diplomas than university graduates, in 2001, there were almost three times as many university graduates as high school degrees. Similar trends, although on a smaller magnitude, are observed among women aged 36-55. In 1981, there were considerably fewer university graduates (with an 8% share of the labour

force) than high school graduates (13% share); however, in 2001 the situation was reversed (20% and 18% respectively).

Changes in the relative supply of university graduates were not as dramatic among young men. While the proportion of the labour force with a high school diploma was almost unchanged in 2000 compared to 1980, around 14%, the proportion of young male labour force participants with a university degree increased from 17% to 22%. Among men 36-55, both the fraction of university graduates and high school graduates increased between 1980 and 2000 in similar proportions. The fraction of university graduates increased from 13% to 21%, while the proportion of high school graduates increased from 9% to 14%.

While changes in weekly hours worked by women and in the types of occupations they hold pose a challenge for the interpretation of the patterns documented above for female workers, it is important to emphasize that the increase in the education premium observed among young men occurred in conjunction with an increase in the relative supply of university graduates in this group, thereby suggesting a growing *relative* demand for university graduates among new entrants to the labour market. Furthermore, the constancy of the university/high school earnings ratio observed among prime-aged men has coincided with a constant relative supply of university graduates in this group.

Taken together, the wage patterns documented for various age-gender groups clearly indicate that the constancy of the university/high school earnings ratio observed in the aggregate, masks offsetting trends found among more narrowly defined demographic groups. Likewise, it is conceivable that the evolution of the education premium observed within age-gender cells conceals diverging trends across industries. This may be so for at least two reasons. First, the factors underlying wage determination in the public sector likely differ from those in the private sector. Second, the pace of technological change, the rate at which firms innovate, the growth of competition within industries or from abroad, and union density—four potentially important factors in the wage determination process—may evolve quite differently across private sector industries. Hence, there is no reason, *a priori*, to assume that the aforementioned patterns will hold for all sectors of the economy.

5. Disaggregating the data by industry

5.1 Descriptive evidence

To assess whether different industries display different patterns, we plot relative median weekly wages of university graduates for each of the four industrial groups defined above: high-knowledge industries, medium-knowledge industries, low-knowledge industries and educational services, health and public administration. We do so for each of the age-gender groups. To assess the robustness of our results, we calculate weekly earnings of university graduates relative to three different groups: individuals with some post-secondary education (excluding those with a university degree), individuals with less than high school education as well as high school graduates. The results are shown in a series of charts in Appendix 1.

For young men and prime-aged women, the education premium—however defined—displays quite different trends in EHPA compared to the three other industrial sectors. In EHPA, relative weekly wages of young male and prime-aged female university graduates fell between 1980 and 2000. However, they rose in all three other sectors. Thus, the declining education premium observed among prime-aged women in the aggregate clearly provides a misleading view of the evolution of education wage differentials in private sector industries.

For all workers except prime-aged men, the education premium rose in low-, medium- as well as high-knowledge industries. Whether the increase was more pronounced in high-knowledge industries than in other industries is unclear. Relative weekly wages of female university graduates employed in HKI do not appear to have risen more than those of their counterparts employed in MKI or LKI. Only young male university graduates employed in HKI have seen their relative (to high school graduates) earnings rise faster than their counterparts employed in MKI or LKI.

In contrast, prime-aged male university graduates employed in LKI have experienced a substantial deterioration in their relative earnings. There is almost no evidence that their counterparts in MKI and HKI have improved their position relative to lower-educated workers during the 1980-2000 period.

Taken together, these results indicate that, for young workers and prime-aged women, the education premium displays similar positive trends across private sector industries. To investigate whether these patterns hold for workers with comparable labour market experience, we now turn to multivariate analysis.

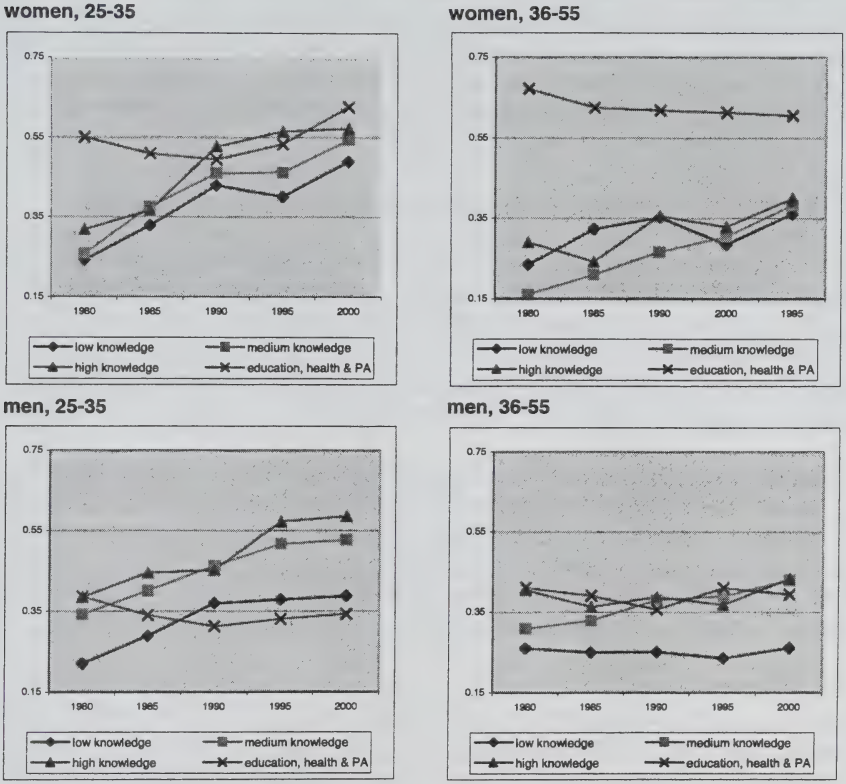
5.2 Multivariate analysis

Our regression analysis of the education premium is based on standard log-wage quantile regressions with dummy variables for different educational attainments entering as explanatory variables. Our control variables include potential experience, potential experience squared, a part-time/full-time dummy variable and a dummy variable for different geographic regions.[7]

7. To calculate the years of experience, we have to know the total number of years spent in school. Since the total number of the years of schooling is not available for all census years, we have created the "potential number of the years of schooling", a conditional mean of total years of schooling for each educational level based on the years in which the real total number of school years is available. The total experience is then calculated as *age* minus *potential years of schooling* minus 6.

Separate median (or 50th quantile) regressions are run for each age-gender-industry combination and each year, thereby providing a fairly flexible specification of wage determination.

Figure 3: University effect (relative to high school diploma), by sex and age group



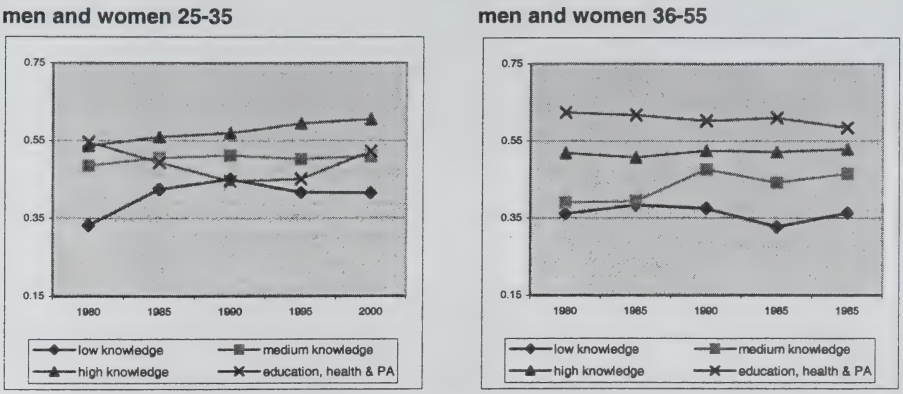
Source: Census data 1980-2000.

Figure 3 shows the resulting university premium trends for LKI, MKI, HKI and EHPA. The regression results confirm most of the patterns found in the raw data. First, consistent with the raw data, the inspection of the university/high school earnings ratio shows a rising education premium in HKI, MKI and LKI for young workers and prime-aged women. Second, there is little evidence that the university wage premium increased faster in HKI than in other sectors. Third, for all age-gender groups, regression results confirm that EHPA displays quite different trends compared to HKI, MKI and LKI. Fourth, as in previous analysis, we see greater differences across age groups than across sectors of varying knowledge intensity. Specifically, in both high- and medium-knowledge industries, the education premium is much greater among young workers than among their older counterparts. Moreover, while the education premium rose in all three private sector industries for young men, it rose only in MKI for prime-aged men.

If men and women of similar ages are close substitutes, then wage patterns should also be examined in samples that combine them. We do so in Figure 4, where separate quantile

regressions are run for each age-industry combination and for each year. Once again, we find little evidence that the education premium grew faster in high-knowledge industries than in other sectors.

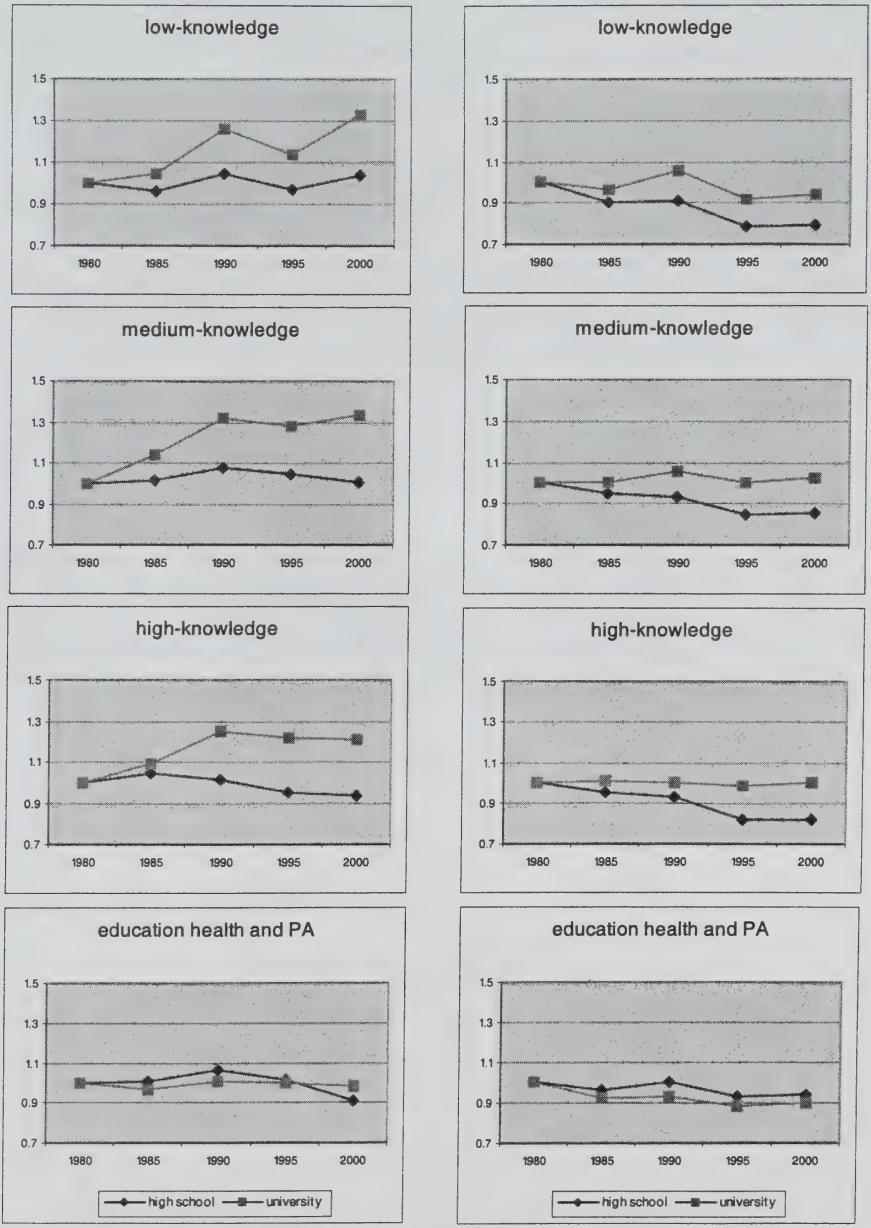
Figure 4: University effect (relative to high school diploma), men and women, by age group



Source: Census data 1980-2000.

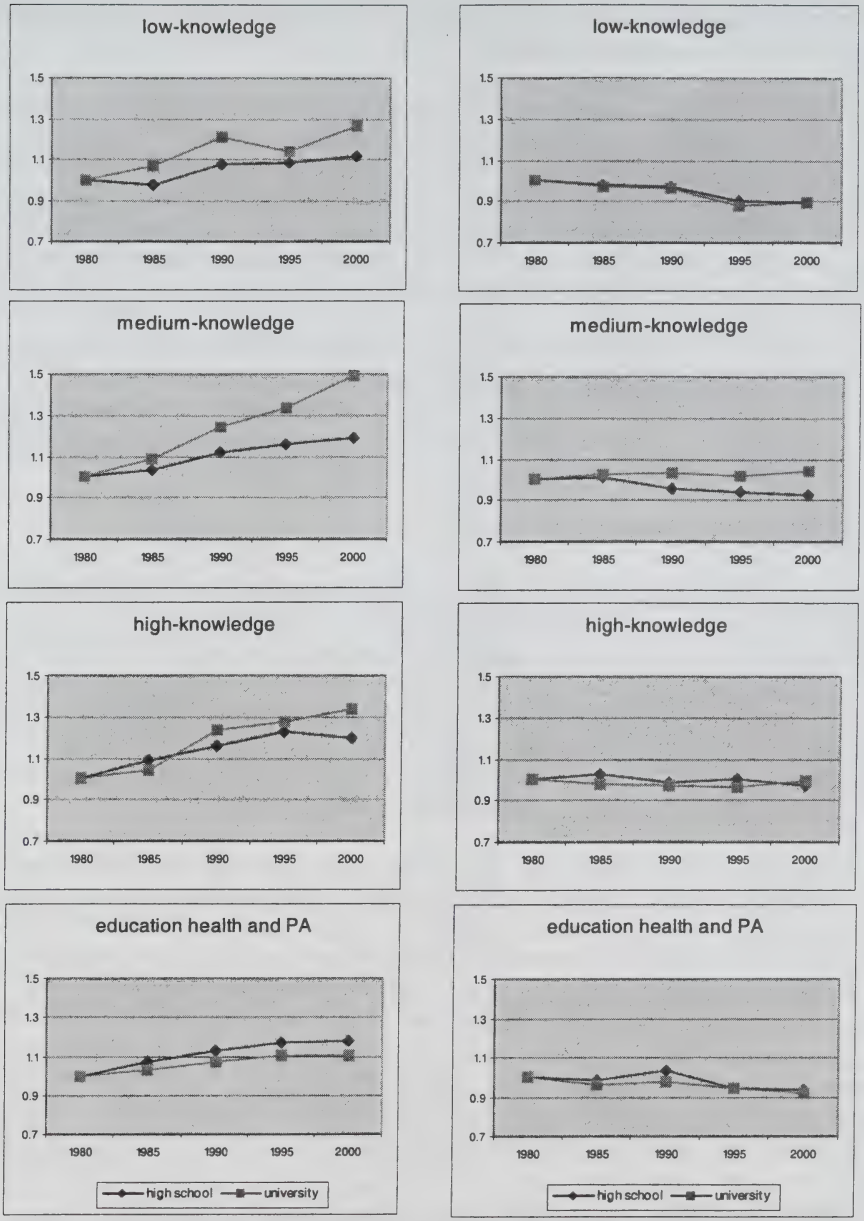
An increase in the education premium does not necessarily imply that *real* weekly wages of university graduates have increased over time. To investigate whether this is the case or not, we compute predicted median log-weekly wages of both university graduates and high school graduates from the aforementioned quantile regressions (Figure 5). The predicted log weekly wages are in 2000 constant dollars and are set equal to 1.0 in 1980.

Figure 5: Predicted median real weekly wage (1980=1); men and women, 25-35 years old, by industry



Source: Data from the 1981, 1986, 1991, 1996 and 2001 Census files.

Figure 6: Predicted median real weekly wage (1980=1); men and women, 36-55 years old, by industry



Source: Data from the 1981, 1986, 1991, 1996 and 2001 Census files.

The results are striking. Predicted real median weekly wages of young male university graduates either fell (in LKI and EHPA) or remained fairly constant. In contrast, those of young female university graduates rose at least 20% in all sectors except EPHA, where they show little

variation. In all three private sector industries, predicted real median weekly wages of young male high school graduates fell almost 20% while those of their female counterparts either remained fairly constant (in MKI and LKI) or fell slightly (in HKI). Thus, while real weekly earnings of young men have been either falling markedly or stagnating, those of young women have been rising substantially or dropping slightly.

Prime-aged women also enjoyed greater earnings growth than their male counterparts in all sectors (Figure 6). Predicted real wages of prime-aged male university graduates and high school graduates have shown remarkably little variation in high-knowledge industries, thereby suggesting that wages of men 36-55 employed in this sector were almost unaffected by whatever structural changes the Canadian economy experienced during the 1980's and 1990's. This does not appear to be the case in low-knowledge industries, where predicted wages of prime-aged male university and high school graduates fell about 10%.

Overall, the descriptive analysis and the regression results presented in this section provide little evidence that relative wages or real wages of university graduates and high school graduates have evolved differently across the three industries of varying knowledge intensity that we consider. Rather, we find sharply distinct patterns between young and prime-aged workers or between men and women.[8]

6. The evolution of the "field" premium

In an economy increasingly based on the use and production of knowledge, the demand for high-skilled workers may evolve quite differently across fields of study. Earnings of university graduates with degrees in engineering, mathematics and computer sciences may be higher than those of other university graduates. Also, the earnings gap between these two types of university graduates may increase as firms adopt new (often, computer-based) technologies and introduce new products and services. So far, Canadian studies (Heisz, 2001; Finnie and Frenette, 2003) have documented earnings differences by field of study at a given point in time, but have not found that earnings have evolved differently across fields of study.

To assess whether the education premium has evolved differently for "applied" fields as compared to other fields of study, we run, for each age-gender group, separate log-wage median regressions in each year for which we have information on field of study, (i.e., for the 1985-2000 period). Our regressions include five educational categories (less than high school, high school completed—which is the omitted group—some post-secondary education, university degree in applied fields and university degree in other fields), four industry controls (HKI, MKI, LKI, and EHPA) as well as the set of control variables used in Section 5. We also run regressions where men and women of a given age group are pooled together, the underlying notion being that male and female workers of similar ages are perfect substitutes. We define applied fields of study as those related to engineering, applied sciences and mathematics. The results are shown in Table 5.

8. It is worth keeping in mind, however, that we examine log differences in medians, which may conceal distributional (interquantile) shifts in relative wages. We checked this possibility by constructing similar profiles for the 20th and 80th percentiles. We were mostly concerned that median profiles may conceal large increases in education premiums among the highest paid workers (that is, highest paid university graduates relative to the highest paid high school graduates). Our comparison of median profiles and 80th percentile profiles in all knowledge-based industries revealed little evidence of any growing divergence that would support this view.

Table 5: Median regression analysis: university/high school premium for "applied" and "non-applied" fields of study, by sex and age group

	Education premium: university/high school			
	1985	**1990**	**1995**	**2000**
Women, 25-35				
Applied degrees	0.547	0.549	0.562	0.613
	(0.017)	(0.016)	(0.014)	(0.013)
Not applied degrees	0.436	0.466	0.481	0.543
	(0.007)	(0.007)	(0.007)	(0.008)
Men, 25-35				
Applied degrees	0.469	0.484	0.524	0.577
	(0.010)	(0.008)	(0.011)	(0.011)
Not applied degrees	0.351	0.380	0.414	0.435
	(0.008)	(0.007)	(0.009)	(0.009)
Women, 36-55				
Applied degrees	0.487	0.509	0.497	0.543
	(0.023)	(0.017)	(0.014)	(0.012)
Not applied degrees	0.528	0.527	0.528	0.523
	(0.008)	(0.006)	(0.005)	(0.005)
Men, 36-55				
Applied degrees	0.426	0.428	0.427	0.443
	(0.008)	(0.007)	(0.007)	(0.007)
Not applied degrees	0.355	0.369	0.383	0.389
	(0.006)	(0.006)	(0.006)	(0.006)
Men & women, 25-35				
Applied degrees	0.616	0.584	0.584	0.616
	(0.009)	(0.008)	(0.009)	(0.008)
Not applied degrees	0.479	0.465	0.463	0.475
	(0.006)	(0.005)	(0.006)	(0.006)
Men & women, 36-55				
Applied degrees	0.632	0.631	0.591	0.591
	(0.010)	(0.008)	(0.007)	(0.007)
Not applied degrees	0.523	0.538	0.523	0.506
	(0.006)	(0.005)	(0.004)	(0.004)

Note: Standard errors in parentheses.
Source: Data from the 1981, 1986, 1991, 1996 and 2001 Census files.

For all age-gender groups except prime-aged women, the university wage premium for applied fields of study is greater than for other fields. For instance, median log wages of young male university graduates with a degree in applied fields were 58 points higher than those of high school graduates in 2000, while the corresponding difference amounted to 44 points in other fields. More important, among young men and women, the education premium for applied fields has not grown more rapidly than that for other fields. In fact, when young men and women are pooled together, the education premium observed in 2000 is, for both fields, almost identical to that observed in 1985. Only among prime-aged women did the education premium for applied fields display a different pattern than that for other fields of study. Thus, along with Heisz (2001) and Finnie and Frenette (2003), we find very little evidence that relative wages of university graduates rose faster in applied fields of study than in other fields.

7. Conclusions

This study has documented the evolution of relative wages and real wages of university graduates and high school graduates over the 1980-2000 period. The results presented confirm that the constancy of the university/high school earnings ratio observed in the aggregate—and documented in several previous studies—masks diverging trends across groups of workers. Our main finding is that even though employment grew much faster in high-knowledge industries than in other sectors during the last two decades, trends in relative wages and real wages of university and high school graduates have displayed remarkably similar patterns across industries. In other words, the acceleration of employment growth in high-knowledge industries has not been accompanied by an acceleration of real and relative wages of university graduates in this sector (relative to other sectors).

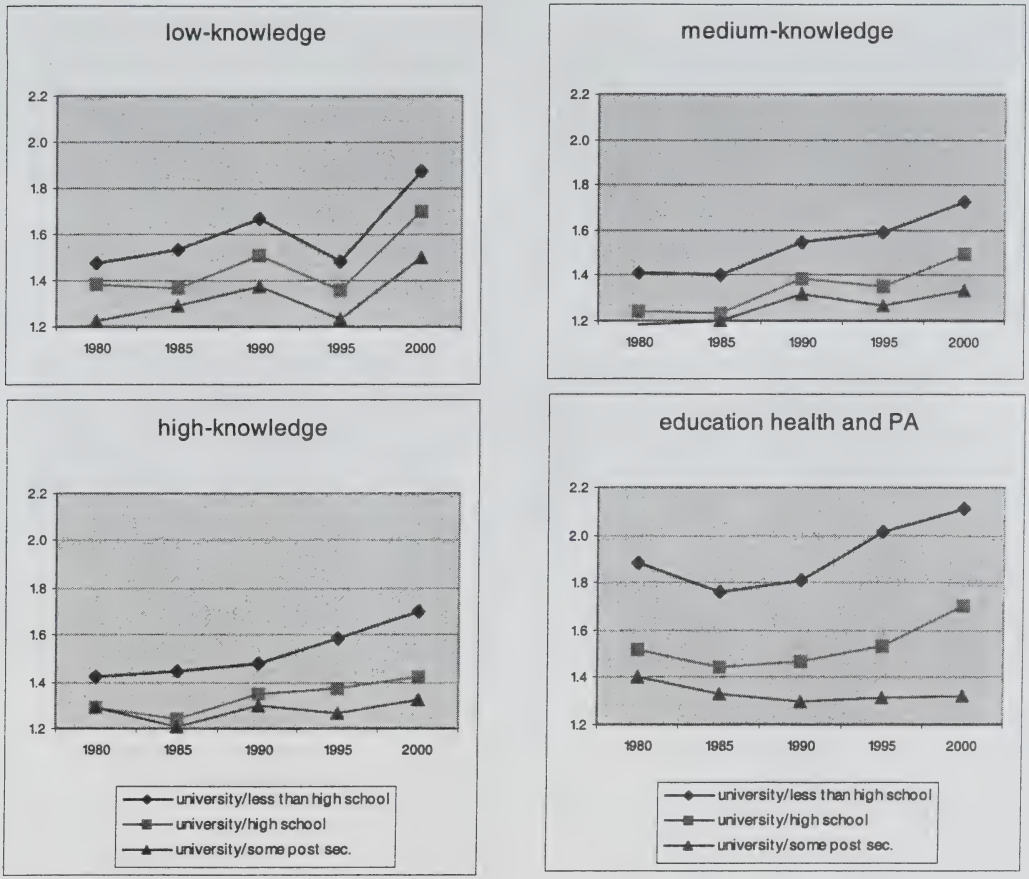
We also found no evidence of an acceleration of (relative) wage growth among university graduates with a degree in applied fields of study. In contrast, we have found markedly different wage patterns across age groups and also between men and women. In all private sector industries, young and prime-aged female university graduates have experienced faster wage growth than their male counterparts. Meanwhile, real wages of young male university graduates have either been stagnating or falling slightly while those of male high school graduates have dropped sharply.

While not inconsistent with the existence of *specific* labour shortages in narrowly defined sectors, our examination of the wage patterns of highly educated workers has revealed little evidence that would support the notion of a *widespread* imbalance between the demand and supply of highly skilled workers in Canada.[9] Rather, it has brought back a simple idea: the possibility that the increasing supply of young women in the labour market influences the wage growth of their male counterparts. Given that young men and women in identical fields of study are very close substitutes, we should expect a negative correlation between young women's growth in labour supply in specific fields of study and young men's wage trajectories in the same fields of study. The extent to which this is true is certainly a question for further research.

9. Gingras and Roy (1998) come to a similar conclusion.

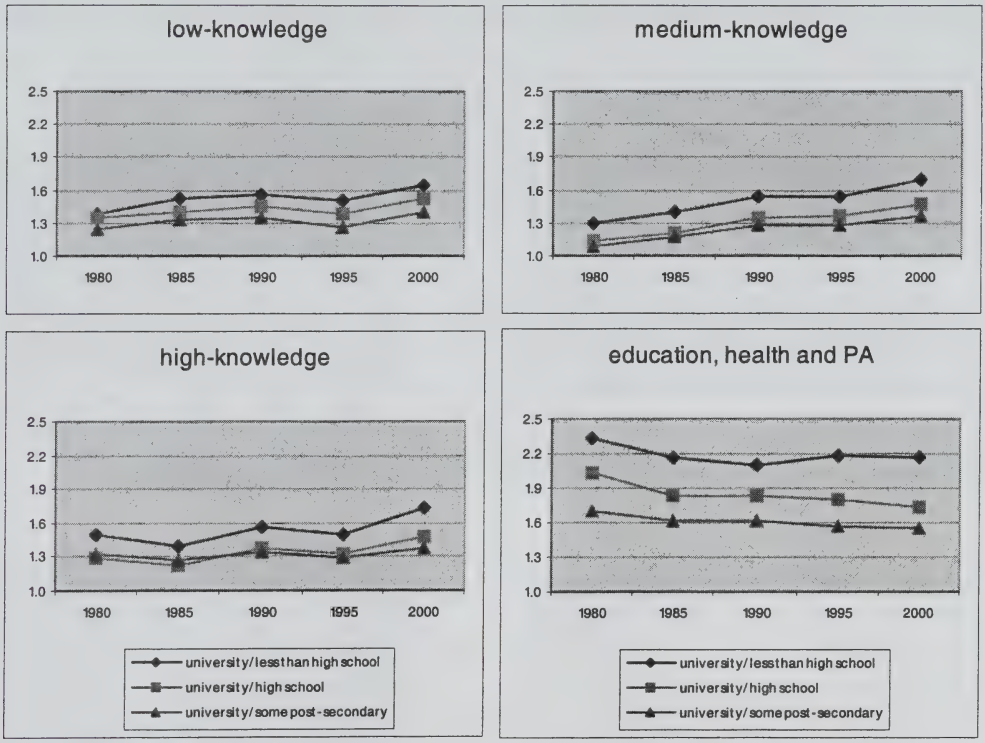
Appendix

Figure A1: Weekly earnings of university graduates relative to 'some post-secondary,' 'high school' and 'less than high school' categories, women, 25-35, by industry



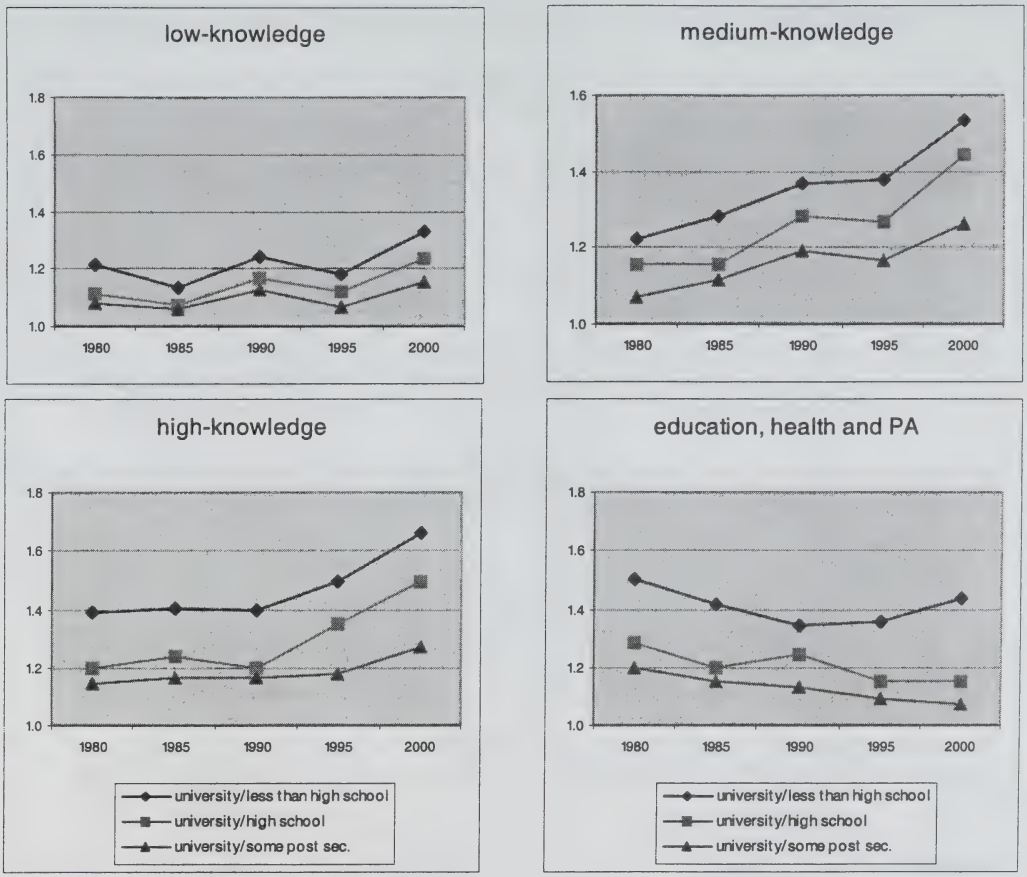
Source: Census data 1980-2000.

Figure A2: Weekly earnings of university graduates relative to 'some post-secondary,' 'high school' and 'less than high school' categories, women, 36-55, by industry



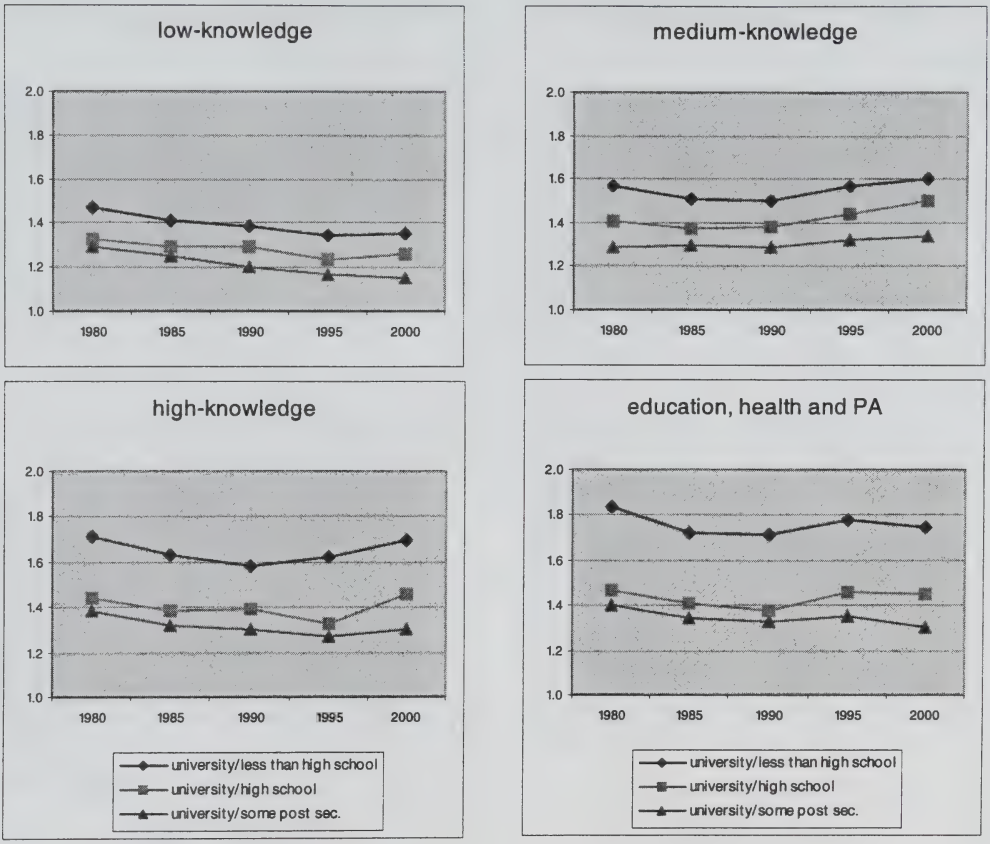
Source: Census data 1980-2000.

Figure A3: Weekly earnings of university graduates relative to 'some post-secondary,' 'high school' and 'less than high school' categories, men, 25-35, by industry



Source: Census data 1980-2000.

Figure A4: Weekly earnings of university graduates relative to 'some post-secondary,' 'high school' and 'less than high school' categories, men, 36-55, by industry



Source: Census data 1980-2000.

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